UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/538,763 | 06/10/2005 | Steven Douglas Slonaker | P27955 | 5550 |

7055 7590 06/24/2008
GREENBLUM & BERNSTEIN, P.L.C.
1950 ROLAND CLARKE PLACE
RESTON, VA 20191

| EXAMINER | |
|---|---|
| GEBRESILASSIE, KIBROM K | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2128 | |

| NOTIFICATION DATE | DELIVERY MODE |
|---|---|
| 06/24/2008 | ELECTRONIC |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

gbpatent@gbpatent.com
pto@gbpatent.com

| Office Action Summary | Application No. 10/538,763 | Applicant(s) SLONAKER, STEVEN DOUGLAS | |
|---|---|---|---|
| | Examiner KIBROM K. GEBRESILASSIE | Art Unit 2128 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *10 June 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-48* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-48* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *10 June 2005* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *09/28/2005*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

## DETAILED ACTION

1. This communication is responsive to application filed on 06/10/2005.

2. Claims 1-48 are presented for examination.

3. Applicants' preliminary amendment to the specification filed on 10/24/2005 have been considered and entered.

### *Priority*

4. Applicant's claim for the benefit of a prior-filed application under 35 U.S.C. 119(e) or under 35 U.S.C. 120, 121, or 365(c) is acknowledged.

### *Drawings*

New corrected drawings in compliance with 37 CFR 1.121(d) are required in this application because Figs. 1-5 are illegible. Applicant is advised to employ the services of a competent patent draftsperson outside the Office, as the U.S. Patent and Trademark Office no longer prepares new drawings. The corrected drawings are required in reply to the Office action to avoid abandonment of the application. The requirement for corrected drawings will not be held in abeyance.

### *Information Disclosure Statement*

5. Documents No. 1666475, 171054, 334695, and 330224, in the IDS filed on 09/28/2005 are not considered because the documents are non-English language documents.

For example, MPEP states:

> (3) **For non-English documents that are cited, the following must be provided:**
> (a) A concise explanation of the relevance, as it is presently understood by the individual designated in 37 CFR 1.56(c) most

knowledgeable about the content of the information, unless a complete translation is provided; and /or
(b) **A written English language translation of a non-English language document, or portion thereof, if it is within the possession, custody or control of, or is readily available to any individual designated in 37 CFR 1.56(c). After the examiner reviews the IDS for compliance with 37 CFR 1.97 and 1.98, the examiner should: (See MPEP § 609.05).**

### *Claim Objections*

6. Claims 44, and 45 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form.

7. Claims 16, 17, 33, 43, and 48 are objected to because of the following informalities:

a. As per claims 16, 17, and 30, claims recites:

> $\underline{\varnothing_{0(ij)} \ldots \varnothing_{n(ij)}}$ are the coefficients of the fitting function, determined following the performing step of setup simulations of image profile as a function of regularly iterated values of lens aberration.

The underlined coefficients are not clear which part of the equation referring to.

For purpose of examination, examiner interpreted as representing the symbol shown in the following equation:

$$= b_{i(w/o\_aberration)} + \sum_{j=2}^{Zn} \underline{\varphi_{0(i,j)} + \varphi_{1(i,j)} c_j + \varphi_{2(i,j)} c_j^{2} + \varphi_{3(i,j)} c_j^{3} + \ldots + \varphi_{n(i,j)} c_j^{n}}$$

b. As per claim 43, and 48, a period (.) is needed at the end of the sentence. Appropriate correction is required.

### ***Specification***

8. The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required: claim 47 recites a “machine readable medium”, which is not described or specified in the specification.

### ***Claim Rejections - 35 USC § 112***

9. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. Claims 1-48 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

c. For example, claims 1, 42, 46, and 47 recite “specified aberration values”. It is unclear where this "specified aberration values" comes from? Is "aberration components" and "aberration values" similar?

d. As per claim 2, it is unclear what does adjustment "goodness" mean? Further, the language “steps are used” seems an intended use.

e. As per claim 15, it is unclear how the evaluating step "eliminates the need for full simulation"?

f. As per claim 22, the language “leads to” seems an intended use.

g. Claim 47 recites “code for adjusting a lens”. It is impossible a “code" by itself to do the steps. A “code” could instruct a computer to execute the steps or processes. Therefore, the preamble should be amended to reflect the code or program instructs the computer to do/execute the steps or processes.

h. As per clams 43, and 48, the claims recite “defined criteria”. It is unclear what “criteria” referring too. Further, the claim recites “judges”, which is vague and indefinite. It could raise many questions such as how the judgment done. Therefore, it needs to substitute “judges” with appropriate word. The claims as whole are indefinite and vague.

11. Claims 44, and 45 provide for the use of the exposure apparatus of claim 42, but, since the claim does not set forth any steps involved in the method/process, it is unclear what method/process applicant is intending to encompass. A claim is indefinite where it merely recites a use without any active, positive steps delimiting how this use is actually practiced.

Claims 44, and 45 are rejected under 35 U.S.C. 101 because the claimed recitation of a use, without setting forth any steps involved in the process, results in an improper definition of a process, i.e., results in a claim which is not a proper process claim under 35 U.S.C. 101. See for example *Ex parte Dunki*, 153 USPQ 678 (Bd.App. 1967) and *Clinical Products, Ltd.* v. *Brenner*, 255 F. Supp. 131, 149 USPQ 475 (D.D.C. 1966).

Therefore, the claims are not examined with respect to art rejection.

See: MPEP section 2173.06 (Prior Art Rejection of Claim Rejected as Indefinite) addresses the issue of applying prior art against such claims:

> ... ***Second, where there is a great deal of confusion and uncertainty as to the proper interpretation of the limitations of a claim, it would not be proper to reject such a claim on the basis of prior art.*** As stated in In re Steele, 305 F.2d 859, 134 USPQ 292 (CCPA 1962), a rejection under 35 U.S.C. 103 should not be based on considerable speculation about the meaning of terms employed in a claim or assumptions that must be made as to the scope of the claims. The first approach is recommended from an examination standpoint because it avoids piecemeal examination in the event that the examiner's 35 U.S.C. 112, second paragraph rejection is not affirmed, and may give applicant a better appreciation for relevant prior art if the claims are redrafted to avoid the 35 U.S.C. 112, second paragraph rejection.

In this case, it would not be proper to reject the claims on the basis of prior art because no limitation or steps are provided.

***Claim Rejections - 35 USC § 101***

12. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

13. Claims 44, 45, 47, and 48 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.

i. Regarding claims 44, and 45, the claimed invention does not fall within at least one of the four categories of patent eligible subject matter recited in 35 U.S.C. 101 (process, machine, manufacture, or composition of matter).

j. Regarding claims 47, and 48, claims are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. For example, claim 45 recites a "machine readable medium". The specification does not provide antecedent basis for the claim terminology "machine readable medium". Therefore, the context the medium used in the claim would fairly suggest to one of ordinary skill as **signals or other forms of propagation and transmission media, typewritten or handwritten text on paper, or other items** failing to be an appropriate manufacture under 35 USC 101 in the context of computer-related inventions. Therefore, for this matter, the claims are non statutory.

k. Because the "machine readable medium" of claims 47 and 48 are not limited to tangible mediums as stated above, the claims as whole are **software per se** resides in non-tangible medium.

**<u>MPEP States:</u>**

*...computer programs claimed as computer listings per se, i.e., the descriptions or expressions of the programs, are not physical "things." They are neither computer components nor statutory processes, as they are not "acts" being performed. Such claimed computer programs do not define any structural and functional interrelation-ships between the computer program and other claimed elements of a computer which permit the computer program's functionality to be realized. In contrast, a claimed computer-readable medium encoded with a computer program is a computer element which defines structural and functional interrelationships between the computer program and the rest of the computer which permit the computer program's functionality to be realized, and is thus statutory. See Lowry, 32 F.3d at 1583-84, 32 USPQ2d at 1035. Accordingly, it is important to distinguish claims that define descriptive material per se from claims that define statutory inventions.*

## *Claim Rejections - 35 USC § 102*

14. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

15. Claims 1-27, 30-41, and 46-48 are rejected under 35 U.S.C. 102(a) as being anticipated by T. Nakashima, K. Higashi, and S. Hirukawa, "Impact of Zernike cross-term on linewidth control" SPIE Vol. 4691, July 15, 2002 .

16. As per claim 1, Nakashima et al discloses a method of calculating estimated image profiles (such as...*imaging performance*...; See: Abstract), comprising the steps of:

providing imaging configuration characteristic data (such as *lithographic performances named linewidth abnormality (LWA) and best focus shift (BFS)*...; See: page 33, "2. Zernike Sensitivity Method", paragraph one);

performing simulation calculations for various levels of aberration components using the imaging configuration characteristic data (such as ....*simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)*...(see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2)....*conduct aerial image calculation of LWA or BFS*...(See: page 34 lines 1-2));

building response surface functional relations between variables of lens characteristics and an image profile of interest using the simulation calculations (such as...*LWA and BFS sensitivities to Zernike components for the set of conditions listed in Table 1 and 2*...; See: page 34, lines 1-6); and

evaluating specified aberration values of a lens in relation to the response surface functional relations to provide an estimate of the image profile in a presence of specified aberration(s) (such as ...*compare the ZSM prediction to the exact aerial image simulation of a given lithographic metric*...;See: page 34, lines 12-17).

17. As per claim 2, Nakashima et al discloses the method of claim 1, wherein the image profiles which result as part of the evaluating step are used as measures of relative lens adjustment goodness in an iterative lens adjustment optimization routine (See; page 37 lines 5-12).

18. As per claim 3, Nakashima et al discloses the method of claim 1, wherein the imaging configuration characteristic data includes lens data, illumination data and pattern data (See for example the simulation conditions of table 3 includes lens data, illumination data and pattern data and also see Figs. 15 and 16).

19. As per claim 4, Nakashima et al discloses the method of claim 3, wherein: the illumination data includes at least one of illumination distribution and illumination wavelength, the lens data includes at least one of lens aberration, numerical aperture, pupil filters and lens configuration; and the pattern data includes object (reticle pattern) layout (See for example the simulation conditions of table 3 includes lens data, illumination data and pattern data and also see Figs. 15 and 16).

20. As per claim 5, Nakashima et al discloses the method of claim 4, wherein the imaging configuration characteristic data further includes at least one of pattern bias characteristic information and lens focus (such as ....*simulation assumption of two*

*lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)...*(see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2).

21. As per claim 6, Nakashima et al discloses the method of claim 1, wherein the simulation calculations are executed for various levels of each aberration component (See: page 34 lines 1-6 for example *Zernike components such as Odd-$\theta$ components...and even-$\theta$ components for LWA and BFS*).

22. As per claim 7, Nakashima et al discloses the method of claim 1, further comprising the step of generating a new set of aberration component impact upon image profile fitted coefficients values using the response surface functional relations each time a new set of input aberration components is presented for image profile calculation (such as *...calculation modify the CD-Focus curve by deltaFocus and deltaCD shifts representing the impact of aberration on the CD-Focus curve...*; See: page 36, "3.4 CD predictions" lines 1-6).

23. As per claim 8, Nakashima et al discloses the method of claim 1, further comprising the step of generating a new set of aberration components impact upon image profile coefficient values using interpolative methods using the response surface functional relations (such as *...calculation modify the CD-Focus curve by deltaFocus and deltaCD shifts representing the impact of aberration on the CD-Focus curve...*; See: page 36, "3.4 CD predictions" lines 1-6).

24. As per claim 9, Nakashima et al discloses the method of claim 1, wherein the response surface functional relations correspond to a sample set of lens characteristics with a final output from application of response surface functional relations being an image profile under the influence of lens aberrations (See: page 34, lines 1-6).

25. As per claim 10, Nakashima et al discloses the method of claim 9, wherein the data configuration characteristic information includes lens characteristics related to variation in single aberration values alone or in combination with one another or with selected items from among the lens characteristics (See: page 35 lines 11-19).

26. As per claim 11, Nakashima et al discloses the method of claim 1, wherein the response surface functional relations are related to a look-up table summarizing the results of interpolating the image profile generated by the simulation calculations of the performing step (See: Table 5).

27. As per claim 12, Nakashima et al discloses the method of claim 11, wherein the look-up table is direct simulation image profile results or of functional coefficients used to calculate the image profile (See: Table 5).

28. As per claim 13, Nakashima et al discloses the method of claim 11, wherein the evaluating step includes determining image profile data points using the look-up table to provide a new image profile associated with specified aberration values (such as *the impact of Z9 before and after adjustment*...See: Figs. 19 and 20).

29. As per claim 14, Nakashima et al discloses the method of claim 1, wherein the evaluating step includes applying interpolated data (such as *…CD-Focus curve*) of the built response surface functional relations to calculate the image profile for specified aberration values (such as *…calculation modify the CD-Focus curve by deltaFocus and deltaCD shifts representing the impact of aberration on the CD-Focus curve...*; See: page 36, "3.4 CD predictions" lines 1-6).

30. As per claim 15, Nakashima et al discloses the method of claim 1, wherein the evaluating step eliminates the need for a full simulation calculation each and every time new specified aberration values are provided and presented for calculation of a new image profile (such as *...adjusting only Z9 on the aberration content...*; See: Figs. 18-20 and corresponding texts).

31. As per claim 16, Nakashima et al discloses the method of claim 1, wherein the building steps includes providing a fitting function (such as *…calculate without aberration….calculate the delta Focus and deltaCD dependencies on aberration ….deltaCD obtained through quadratic Zernike Sensitivity method (i.e. fitting function)...*; See: page 34, "3.1 Procedure" lines 1-6).

32. As per claim 17, Nakashima et al discloses the method of claim 16, wherein the fit coefficient are generated from a single aberration polynomial coefficient or from at least one of multiplication division of one aberration polynomial coefficient by another (such as *…Quadratic ZSM and also see equation 1 and 2 of page 34*).

33. As per claim 18, Nakashima et al discloses the method of claim 16, wherein the coefficient are stored for each simulation calculation following their determination via fitting to the simulation calculation of the performing step (such as ...*Quadratic ZSM and also see equation 1 and 2 of page 34*).

34. As per claim 19, Nakashima et al discloses the method of claim 16, wherein n=4 (See: equation 1, and 2).

35. As per claim 20, Nakashima et al discloses the method of claim 16, wherein Zn=37 (See: Equation 1, and 2).

36. As per claim 21, Nakashima et al discloses the method of claim 1, wherein each different aberration value applied during the performing step leads to one full image simulation calculation (See: page 34, lines 1-6).

37. As per claim 22, Nakashima et al discloses the method of claim 1, wherein the evaluating step provides one output image profile for each one set of specified input aberration values (See: page 34, lines 5-6).

38. As per claim 23, Nakashima et al discloses the method of claim 1, wherein the response surface function relations are built relating any of variables: (i) position within a specified image plane, (ii) intensity or amplitude, (iii) focus, and (iv) all component aberration levels (such as ....*focus and all component aberration levels*...; See: page 34 lines 1-6).

39. As per claim 24, Nakashima et al discloses the method of claim 1, wherein the performing step includes the steps of: defining a simulation pixel as a unit of horizontal or vertical, position into which an aerial image is divided; calculating aerial image

amplitude or intensity on each simulation pixel; and executing the calculations at defocus positions to provide image profile data including focus response (See: Figs. 19 and 20 and corresponding texts).

40. As per claim 25, Nakashima et al discloses the method of claim 1, wherein the evaluating step includes summing an impact from all specified aberration values or combinations of values defined as aberration coefficients for image profile reconstruction (such as *the impact of Z9 before and after adjustment...*See: Figs. 19 and 20).

41. As per claim 26, Nakashima et al discloses the method of claim 25, wherein the summing step provides an output of intensity or amplitude vs. at least one of position and focus for the specified aberration values which are an arbitrary set of aberration values (See: Fig. 18).

42. As per claim 27, Nakashima et al discloses the method of claim 1, wherein the evaluating step is performed using a linear equation using fixed functions with coefficients determined in the building step (such as *quadratic fitting function*).

43. As per claim 30, Nakashima et al discloses a method of calculating estimated image profiles, comprising the steps of:

performing simulation calculations for various levels of aberration components using image configuration characteristic data (such as *....simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)...*(see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2)*....conduct aerial image calculation of LWA or BFS...*(See: page 34 lines 1-2));

building response surface functional relations between variables of the image configuration characteristics and the image profile of interest using the simulation calculations (such as*...LWA and BFS sensitivities to Zernike components for the set of conditions listed in Table 1 and 2...*; See: page 34, lines 1-6) as data input to be fit (such as *...conduct aerial image calculation of LWA or BFS...*(See: page 34 lines 1-2)*...calculate without aberration....calculate the delta Focus and deltaCD dependencies on aberration ....deltaCD obtained through quadratic Zernike Sensitivity method (i.e. fitting function)...*; See: page 34, "3.1 Procedure" lines 1-6) using:

summing an impact from at least one of all new specified aberration coefficients and combinations of aberration coefficients from the built response surface functional relations to provide lens adjustment data (See; page 37 lines 5-12).

44. As per claims 31-41, the instant claims recite substantially same limitation as the above rejected claims 3, 4, 6-8, 18-20, 23, 24, 26, and therefore rejected under the same rationale.

45. As per claim 46, Nakashima et al discloses a system for providing optimal image profiles through the optimization of specified aberration components, according to their associated impact upon image profile, comprising:

means for performing simulation calculations for various levels of aberration components using characteristic data; means for building response surface functional relations between variables of lens characteristics using the simulation calculations (such as *....simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)...*(see: page 33, "2. Zernike Sensitivity

Method" paragraph two and also tables 1, and 2)....*conduct aerial image calculation of LWA or BFS*...(See: page 34 lines 1-2));

means for evaluating specified aberration values of a lens in relation to the response surface functional relations to provide image profile estimates for the specified aberration values (such as ...*compare the ZSM prediction to the exact aerial image simulation of a given lithographic metric*...;See: page 34, lines 12-17); and

means for applying the aberrated image profile estimates in an optimization calculation method which judges image profile information against defined criteria as part of a lens adjustment optimization calculation (See; page 37 lines 5-12).

46. As per claim 47, the instant claim recites substantially same limitation as the above rejected claim 1, and therefore rejected under the same rationale.

47. As per claim 48, Nakashima et al discloses the machine readable code of claim 47, wherein the at least one module applies the aberrated image profile estimates in an optimization calculation method which judges image profile information against defined criteria as part of a lens adjustment optimization calculation (See; page 37 lines 5-12).

### ***Claim Rejections - 35 USC § 103***

48. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

49. Claims 28, 29, and 42-43 are rejected under 35 U.S.C. 103(a) as being unpatentable over T. Nakashima, K. Higashi, and S. Hirukawa, "Impact of Zernike cross-term on linewidth control" SPIE Vol. 4691, July 15, 2002 as applied to claims 1-27, 30-41, and 46-48 above, and further in view of Y. Shiode, S. Okada, H. Takamori, H. Matusda, and S. Fujiwara, "Method of Zernike Coefficient Extraction for Optics Aberration Measurement" SPIE Vol. 4691, 2002.

50. As per claim 28, Nakashima et al clearly teaches the building and evaluating steps using quadratic fitting function. However, he did not explicitly state a sinusoidal fitting function. Official notice is taken that it was known at the time of the invention to implement the building and evaluating steps using a sinusoidal fitting function. This implementation would have been obvious because one of ordinary skill in the art would be motivated to change quadratic Zernike fitting function to sinusoidal fitting functions using well known trigonometric functions.

51. As per claim 29, the same Official Notice will apply as claim 28.

52. As per claim 42, Nakashima et al discloses an exposure apparatus, comprising:

a system for providing optimal image profiling (such as *aerial image simulation*), including:

means for providing image configuration characteristic data;

means for performing simulation calculations for various levels of aberration components using the image configuration characteristic data (such as ….*simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)*...(see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2)….*conduct aerial image calculation of LWA or BFS*...(See: page 34 lines 1-2));

means for building response surface functional relations between variables of lens characteristics associated with the image configuration characteristic data using the simulation calculations (such as…*LWA and BFS sensitivities to Zernike components for the set of conditions listed in Table 1 and 2*…; See: page 34, lines 1-6); and

means for evaluating specified aberration values of a lens in relation to the response surface functional relations to provide image profile estimates for the specified aberration values (such as …*compare the ZSM prediction to the exact aerial image simulation of a given lithographic metric*…;See: page 34, lines 12-17).

Nakashima et al fails expressly to disclose an illumination system that projects radiant energy through a mask pattern on a reticle R that is supported by and scanned using a wafer positioning stage; and at least one linear motor that position the wafer positioning stage.

Shiode et al disclose an illumination system that projects radiant energy through a mask pattern on a reticle R that is supported by and scanned using a wafer positioning stage (See: Fig. 1 for example, illumination aperture and Reticle and Wafer); and at least one linear motor that position the wafer positioning stage (See: Fig 1 the rotation of Illumination aperture).

It would have been obvious to one of ordinary skill in the art to modify the teachings of Nakashima et al with the teachings of Shiode et al to produce different displacement values and angles.

53. As per claim 43, Nakashima et al discloses the apparatus of claim 42, further comprising means for applying the aberrated image profile estimates in an optimization calculation method which judges image profile information against defined criteria as part of a lens adjustment optimization calculation (See; page 37 lines 5-12).

54. As per claim 44, a device manufactured with the exposure apparatus of claim 42 (not examined see *Claim Rejections - 35 USC § 112 #11 above*).

55. As per claim 45, a wafer on which an image has been formed by the exposure apparatus of claim 42 (not examined see *Claim Rejections - 35 USC § 112 #11 above*).

***Conclusion***

56. All claims are rejected.

57. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

I. For example,

# Further pursuit of correlation between lens aberration content and imaging performance

Steve Slonaker
*Nikon Precision Inc., Belmont, CA, 94002*

teaches:

**Abstract**

As further experience is gained and data is gathered using direct Phase Measurement Interferometry (PMI) techniques in the production of leading edge lithography lenses, some progress is being made towards the goal of assigning specific image degradation symptoms to specific types of aberration content[1]. However, since both the specific object being imaged and the illumination distribution being applied to the projection will define the spatial frequency content of a given image[1-3], any attempt at analyzing aberration sensitivity must also address these constraints.

The paper summarizes the results of image simulation studies, wherein the through-focus aerial image intensity distribution is initially described by a set of metrics and coefficients. These "imaging metrics" (for example, curvature or tilt of *CD vs. Focus* functional representation) are then directly correlated to various types of aberration content, as represented through Zernike coefficients. Some type of imaging responses are seen to correlate to specific aberrations, while others do not. A method for specifying and identifying threshold levels of "influencing aberration" are determined from the sensitivit studies executed.

In particular, the imaging of alternating phase shift mask patterns in the region of half-λ will be investigated.

Further,

## 1. Current Typical Applications of Image Simulations

Aerial image simulations have been found particularly useful in the investigation of the response of a given image to the variation of some input variable. For example, aerial image CD variation as a function of both dose and focus is a typical application. Many different variations of both input variables and monitored responses have been successfully applied[4-8]. By simulating the aerial image and monitoring some associated metric (e.g. aerial image CD or image shift), determinations can be made regarding optimum settings of the input variables. Typical input variables include: reticle CD delta, delivered dose delta, focus position delta, and aberration content delta[9], and the more global variables of NA and σ. The characterization of the CD/Focus imaging response to aberration content delta is the focus of this paper.

**2. Aberration Sensitivity Modeling**

A new set of simulations was executed towards the goal gaining insight into the general sensitivity of CD/Focus response to each independent Zernike component, as well as to issues of aberration balancing.

For the given imaging configuration (here: $\lambda$=248.385 nm, NA=0.68, $\sigma$=0.40) and reticle pattern (see Figure 1), aerial image simulations have been performed whereby the level of aberration contribution from each of the independent Zernike terms has been systematically varied. The magnitude of the contribution per Zernike term is tracked in units of rms wavefront error. In this experiment, a range of "+/-25 m$\lambda$" of rms aberration was introduced per each Zernike term. The quotes are used in the previous sentence since, strictly speaking, it is not appropriate to speak of "negative" rms values. Formally, the range of applied aberrations corresponded to using a positive coefficient yielding 25 m$\lambda$ rms wavefront error, stepping the coefficient values smaller, through zero, and finally to the negative coefficient which yields 25 m$\lambda$ rms error. A total of 11 steps were used per Zernike coefficient.

***Examiner Remarks***

58. Examiner's Note: **Examiner has cited particular columns and line numbers in the references applied to the claims above for the convenience of the applicant.** Although the specified citations are representative of the teachings of the art and are applied to specific limitations within the individual claim, other passages and figures may apply as well. **It is respectfully requested from the applicant in preparing responses, to fully consider the references in their entirety as potentially teaching all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner.**

***Examiner Request***

59. **In the case of amending the claimed invention, Applicant is respectfully requested to indicate the portion(s) of the specification which dictate(s) the structure relied on** for proper interpretation and also to verify and ascertain the metes and bounds of the claimed invention.

**MPEP states:**

> "…with respect to newly added or amended claims, applicant should show support in the original disclosure for the new or amended claims. See MPEP § 714.02 and § 2163.06."

## ***Communications***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kibrom K. Gebresilassie whose telephone number is 571-272-8571. The examiner can normally be reached on 8:00 am - 4:30 pm Monday to Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kamini S. Shah can be reached on 571-272-2279. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Kamini S Shah/

Supervisory Patent Examiner, Art Unit 2128

/K. K. G./

Examiner, Art Unit 2128